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ABSTRACT

This module is the sixth of 10 modules in the competency-based electronics series. Introductory materials include a listing of competencies addressed in the module and a cross-reference table of instructional materials. Two instructional units cover: (1) AM/FM transmitter and receiver basics; and (2) satellite systems, antennas, and analyzers. Each unit includes some or all of the following components: performance objectives; information sheets; transparency masters; handouts; assignment sheets; job sheets; and unit test with answer key. Special instructions, suggested teaching approaches, and suggested supplemental materials are included in the notes to the instructor section near the beginning of each unit. (YLB)

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ED325676

ELECTRONICS
Module

6

RECEIVERS AND TRANSMITTERS

70-5006-1
Instructor's Guide

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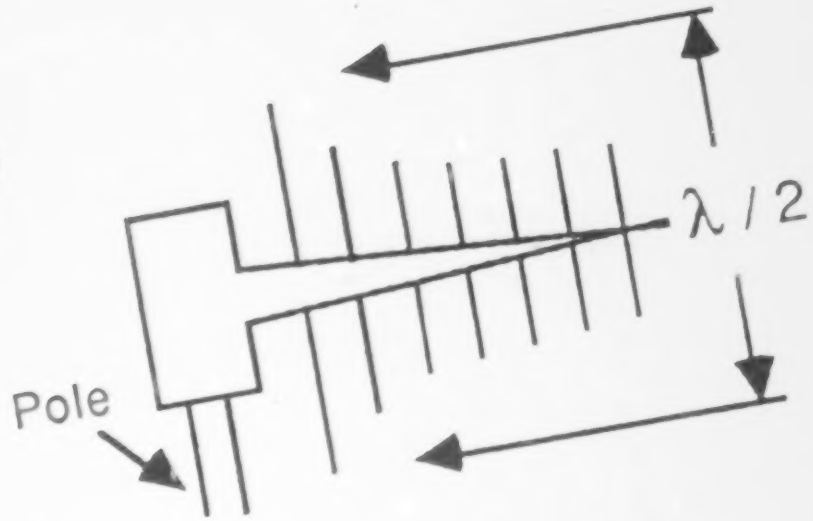

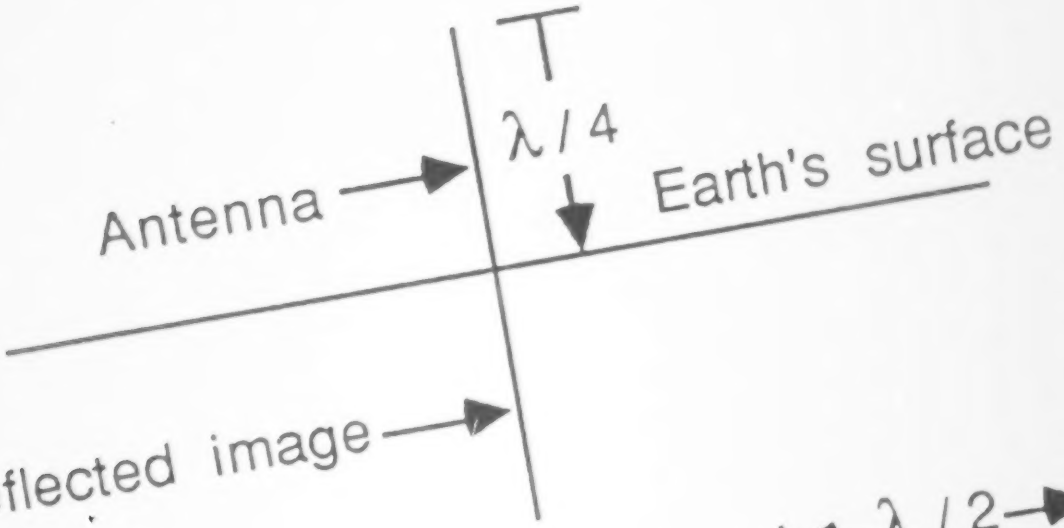

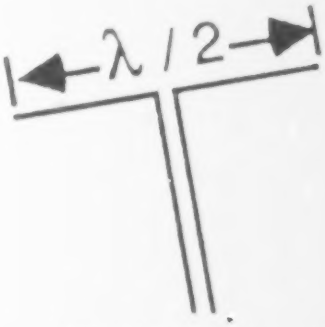

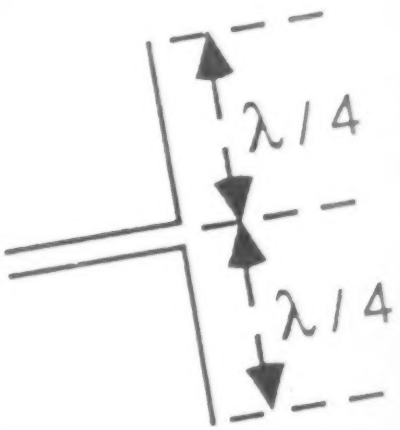

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3: *Digital Logic Application* by Ed Carter and Mark Murphy
4: *Circuit Construction Techniques* by Don Slack
5: *Semiconductor Devices and Applications* by John Chappell, Bill Franken and Mark Murphy
6: *Receivers and Transmitters* by Jim Everett
7: *Testing and Troubleshooting* by Don Slack
8: *Microprocessor and Computer Systems* by Don Slack
9: *Optical Electronics* by Bill Franken
10: *Electromechanical Devices and Controllers* by Ed Carter

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ELECTRONICS

Module 6: Receivers and Transmitters

by

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1990

Instructor's Guide
Catalog No. 70-5006-I

FOREWORD

Once again, we are indebted to the teachers and administrators who provide their time, efforts and professionalism to develop curriculum for trade, technical and industrial education programs. This electronics guide is an outstanding example of what can be accomplished when the right people with the right attitude get together. Committee members worked hard over several years' time in advisory, writing, technical consultation and field-test capacities.

This guide is designed to be totally integrated with the Vocational Instructional Management System. It is hoped that all guides produced under our supervision will help classroom teachers manage instruction. A curriculum guide is more than a resource--it is an integral part of the management system. Rather than impeding instruction, it should guide and facilitate instruction.

This guide's format has been set up for competency-based teaching and testing. Unit tests evaluate specific competencies and can be used with the Vocational Administrative Management System (VAMS). Information sheets, transparency masters, job sheets, assignment sheets and test items are keyed to specific competencies. A cross-reference table has been included to quickly identify parts of the curriculum that relate to specific competencies. The material has also been packaged for students.

Although this guide may be a new format for some teachers, we are confident that, when used as designed, time spent by teachers and students will become more productive. Any future electronics curriculum modifications will begin with this guide. The electronics field is undergoing constant and considerable change. We will annually evaluate the need to update this guide on a module-by-module basis. Your suggestions regarding areas for improvement are both encouraged and appreciated.

Judith Moore, supervisor
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Department of Elementary and Secondary Education

Charles "Chuck" Waibel, director
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Department of Elementary and Secondary Education

ACKNOWLEDGMENTS

This electronics guide represents a continuing commitment to Missouri's Vocational Instructional Management System (VIMS). The guide has been keyed to the electronics competency profile developed by industry and education professionals in the state.

When searching for current electronics materials to adopt or utilize in the guide's development, comparable materials were found from the Mid-America Vocational Curriculum Consortium (MAVCC), of which Missouri is a member. MAVCC materials, therefore, have been relied upon as a resource for this guide. A debt of thanks is owed to the entire MAVCC organization for the research and development of these electronics materials.

Special appreciation is given to the writers (Ed Carter, John Chappell, Jim Everett, Bill Franken, Mark Murphy, Don Slack and Bill Tharp) for their self-motivation, reliability and technical expertise. IML employees Crystal Dietiker and Donna Curtis contributed greatly to the guide's production.

These industry representatives and educators contributed to the guide as members of the advisory committee.

Ed Carter, Columbia Area Career Center, Columbia
John Chappell, State Fair Community College, Sedalia
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Educators who field-tested the guide in the classroom include the following.

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Bob Chenoweth, Chillicothe AVTS
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Linda Miller, St. Louis Community College at Florissant Valley
Don Slack, Graff Area Vocational Center, Springfield
Lawrence Vance, Rolla AVTS
Mark Ward, Lewis & Clark Technical School, St. Charles

Support and contributions of IML staff members were instrumental to this module's development.

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Amon Herd, associate director
Phyllis Miller and Dan Stapleton, assistant directors
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Hsiu-Nien (Shelley) Chen, student assistant - technical
Donna Curtis and Lori Holliday, word processors
Mary Beth Ramsey, student assistant - clerical

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COMPETENCIES ADDRESSED IN THIS MODULE

F. Frequency Generation

3. Describe operation of phase lock loop (PLL)
6. Test and repair phase lock loop (PLL)

G. Receivers and Transmitters

1. Identify and describe the stages of a radio receiver, AM/FM
2. Identify and describe the stages of a radio transmitter, AM/FM
3. Describe the basic operation of microwave and satellite transmitter/receiver systems
4. Describe the operation of transmitter/receiver antennas

H. Test Equipment

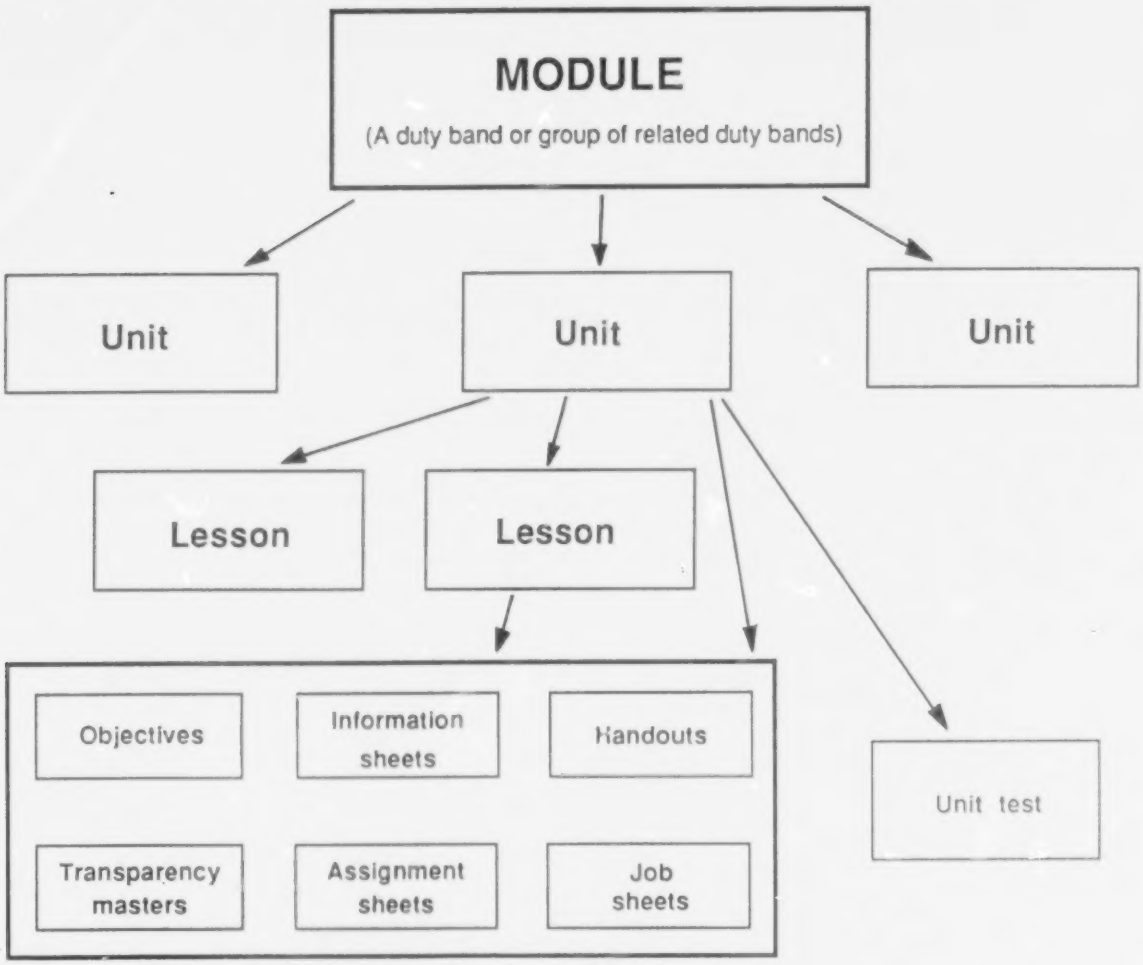
5. Describe the function and application of analyzers; i.e., Signature, Data, LOGS, Spectrum or Components

HOW TO USE THIS PUBLICATION

GUIDE COMPONENTS

Units of instruction

This Electronics guide contains ten modules of instruction. Within each module are instructional units including some or all of the following components: performance objectives, information sheets, transparency masters, handouts, assignment sheets, job sheets and a unit test. Special instructions on audiovisuals, supplies, etc. are included in the Notes to the Instructor section near the beginning of each unit.



Competency profile

On the Missouri competency profile, tasks are divided into general subject areas, or duty bands, which are identified by a capital letter. Under each duty band are related tasks (competencies), which are identified by an Arabic numeral. To evaluate the student on performance of the competencies, a 3-2-1-N grading system is used, where:

- 3 = **Mastery** - can work independently with no supervision
- 2 = **Requires supervision** - can perform job completely with limited supervision
- 1 = **Not mastered** - requires instruction and close supervision
- N = **No exposure** - no experience or knowledge in this area

Cross-reference table (color-coded white)

Once the numbering system is understood, this table quickly reveals how the instructional components of the module relate to Missouri competencies. On the competency profile, tasks are divided into general subject areas, or duty bands, which are identified by a capital letter. Under each duty band are related tasks (competencies), which are identified by an Arabic numeral.

On the cross-reference table, unit numbers are represented by Roman numerals (I, II, III, etc.). Lessons within a unit are shown with Arabic numerals. Therefore, the first objective in Lesson 1 is numbered 1.1, the second is 1.2, and so on. Other components of the module (transparencies, handouts, assignment sheets and job sheets) also use this numbering system. By looking at the cross-reference table, the instructor can quickly determine what test questions or job sheets a student needs to receive an evaluation on a particular competency.

Objectives (color-coded white)

Each unit is based on performance objectives which state the measurable unit and specific behavioral or performance objectives that students are expected to achieve. Since the objectives of the unit provide direction for the teaching-learning process, it is important for the teacher and students to have a common understanding of the objectives' intent. Teachers should feel free to add/adapt objectives which will fit the material to student and community needs. Supporting material will, of course, need to be added for any new objectives.

Table of contents, references, notes to the instructor (color-coded pink)

These pages have been coded pink for instructor use only. The reference section lists materials used as sources in developing the material. Special instructions on audiovisuals, supplies, etc. are included in the Notes to the Instructor section.

Information sheets (green)

Presented in outline form for clarity, these pages provide content essential for meeting the cognitive (knowledge) objectives in the unit. Students should study the information sheets before class discussion or completion of assignment sheets. **CAUTION** statements indicate possible equipment damage, while **WARNING** statements recommend procedures to avoid bodily injury. Handouts and transparency masters have been keyed in the information sheets for instructional use.

Transparency masters (white)

Transparencies provide information by visually reinforcing or clarifying ideas presented in the information sheets. They are effective when identification is necessary and direct the class's attention to the topic of discussion. Transparencies should be left on the screen only when topics shown are under discussion, however.

Handouts (white)

Whenever more detailed information than can be presented in a transparency is needed, a handout is used. Handouts give the students additional information that can be kept with their class notes or student references.

Assignment sheets (tan)

Assignment sheets furnish paper-and-pencil practice to develop the knowledge necessary as a prerequisite to skill development. They can be given to students for class completion or used as homework assignments. Answer sheets (color-coded pink) can be used by the student or instructor to check progress.

Job sheets (blue)

These evaluation instruments are provided for two purposes: to outline steps of procedure and to check student performance mastery. Job sheets begin with a list of tools and materials needed for the activity. Job sheets furnish potential employers with a picture of skills being taught and performance which might

be reasonably expected from a vocational student. The spaces to the right of the page on a job sheet assist the instructor in evaluating a student on a particular activity. This 3-2-1-N grading system is the same as the one used on the competency profile.

Unit test (yellow)

Competency-based tests are designed to help eliminate subjective testing and to improve student evaluation and accountability. Specific competencies and test questions are linked on the answer key. These unit tests have been written to be used with computerized VAMS (Vocational Administrative Management System), utilizing Scantron sheets for computer-recording of test answers.

The unit test may be eliminated if the competency was thoroughly evaluated by job sheets. However, an emphasis should be placed on cognitive as well as performance skills. If the objective or competency will be evaluated by a job sheet, it is often necessary to determine by a written test whether the student understands enough of the material to perform the job sheet.

SUGGESTED ACTIVITIES

The following list of suggested activities may be helpful, especially to the beginning instructor.

1. Provide students with objective sheet and information sheets.
2. Discuss unit and specific objectives.
3. Discuss information sheets, assignment sheets and/or job sheets, lesson-by-lesson.
4. Have students do assignment sheet(s) to satisfactory levels.
5. Give students unit test.
6. After successful completion of the test, have students do job sheet(s).

Students should perform the following activities.

1. Read objective sheet.
2. Study information sheets.
3. Do assignment sheet(s).
4. Take unit test.
5. Do job sheets.

PACKAGING

This Electronics guide has been packaged with the entire class in mind. For the teacher, a complete instructor's guide contains all ten modules. In the student reference, selected portions have been reproduced for student use (objectives page, information sheets, handouts). Student work sheets (assignment sheets, job sheets, unit tests) have been packaged together for student distribution as the instructor deems necessary.

In the student reference, page numbers do not run consecutively because some pages have been removed that appear only in the instructor's guide.

MODULE 6: RECEIVERS AND TRANSMITTERS

CROSS-REFERENCE TABLE OF INSTRUCTIONAL MATERIALS

Compe-tency	Instructional Objective	Transparency Master	Handout	Assignment Sheet	Job Sheet	Test Item	Notes
F1-2							in Semiconductor module
F3	I 3.1, 3.2		I 3.1, 3.2	I 3.1		I 12, 19, 21	
F4-5							in Semiconductor module
F6							I-Notes to instructor
F7							in Semiconductor module
G1	I 1.2, 2.1-2.3					I 1, 3-6, 8, 11, 17, 18, 20	
G2	I 1.1, 1.3		I 1.1			I 2, 7, 9-10, 13-16	
G3	II 1.1, 1.2					II 1-4, 12, 13, 16	
G4	II 2.1, 2.2		II 1.1			II 5, 7-11	
H5	II 3.1, 3.2		II 3.1	II 3.1		II 6, 14, 15	

MODULE: RECEIVERS AND TRANSMITTERS

UNIT I: AM/FM TRANSMITTER AND RECEIVER BASICS

UNIT OBJECTIVE

Upon completion of this unit, the student should be able to identify and describe the stages of AM and FM radio transmitters. This knowledge will be evidenced by achieving th[illegible]ified score on the unit test.

SPECIFIC OBJECTIVES

After completion of the lessons in this unit, the student should be able to:

1.1 Define terms used when describing AM and FM transmitters. (competency G2)

1.2 Categorize AM and FM transmitters according to frequency generation and modulation technique. (competency G1)

1.3 Identify the stages of typical AM and FM transmitters. (competency G2)

2.1 Define terms used when describing AM and FM receivers.

2.2 Describe the stages of typical receivers.

2.3 Determine mixer outputs and IF frequencies. (competency G1)

3.1 Define terms used when describing phase-locked loop (PLL) circuits.

3.2 Determine output frequencies of PLL circuits. (competency F3)

MODULE: RECEIVERS AND TRANSMITTERS

UNIT I: AM/FM TRANSMITTER AND RECEIVER BASICS

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Notes to the instructor

D. Lesson plans

1. Lesson 1: TRANSMITTERS

   a. Information outline

   b. Handout

      HO 1.1: Typical transmitter

2. Lesson 2: RECEIVERS

   a. Information outline

3. Lesson 3: PHASE-LOCKED LOOPS (PLL)

   a. Information outline

   b. Handouts

      HO 3.1: PLL systems
      HO 3.2: Motorola flowchart supplement

   c. Assignment sheet

      AS 3.1: Transmitter and receiver practice

E. Unit test

F. Answers to unit test

REFERENCES

A. Books

1. Douglas-Young, John. Illustrated Encyclopedic Dictionary of Electronics. West Nyack, NY: Parker Publishing Co., Inc., 1981.

2. Graf, Rudolf F. Modern Dictionary of Electronics. 5th ed. Indianapolis, IN: Howard W. Sams & Co., Inc., 1977.

3. Schuler, Charles A. Electronics: Principles and Applications. 3rd ed. New York: McGraw-Hill, 1989.

4. Shrader, Robert L. Electronic Communication. 5th ed. St. Louis: McGraw-Hill, 1985.

B. Service manual

1. RADIUS™ Service Manual (68-80101W58-A). Schaumburg, IL: Motorola, Inc., 1988.

C. Curriculum guide

1. Willison, Neil L., and James K. Shelton. Basic Electronics II. Stillwater, OK: Mid-America Vocational Curriculum Consortium, 1981.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. Examples of the type of information provided to service technicians by Motorola is included (HO 3.2). This is provided to facilitate discussion and allow the instructor to pursue relevant subjects to the depth desired.

2. In lesson 2, section III-C, the two LO frequency examples shown are usually referred to as high-side and low-side injection (respectively in each example). Either one will work, but the manufacturer usually designs the system to use only one or the other at specific frequencies.

3. In lesson 3, only cognitive material is covered for troubleshooting PLL systems **(competency F6)**. An excellent method of providing troubleshooting practice, if desired, is with relatively inexpensive 40-channel CB radios. A very good article was printed in the Popular Electronics magazine (July 1980) entitled "Troubleshooting Phase-Locked-Loop Circuits" by Harold Kinley. This article specifically addresses typical CB radio PLL circuits.

B. Suggested supplemental materials

1. Adamson, Thomas A. Electronic Communication Systems and Circuits. Albany, NY: Delmar, 1988.

2. Frenzel, Louis. Communication Electronics. St. Louis: McGraw-Hill, 1988.

3. Kinley, Harold. "Troubleshooting Phase-Locked-Loop Circuits." Popular Electronics July 1980.

4. Miller, Edward A. Communication Electronics. Englewood Cliffs, NJ: Prentice-Hall, 1989.

MODULE: RECEIVERS AND TRANSMITTERS

UNIT I: AM/FM TRANSMITTER AND RECEIVER BASICS

LESSON 1: TRANSMITTERS

I. Terms and definitions

A. AF (audio frequency)--frequencies within the range of human hearing; usually considered to be approximately 20-20,000Hz (20KHz)

B. AM (amplitude modulation)--process by which the message signal is used to vary the amplitude of the carrier signal

C. Carrier signal--oscillating signal capable of being transmitted through cables or antenna systems; can have information impressed upon it, usually by using AM or FM techniques

D. Crystal--piezoelectric device that oscillates at a frequency determined by the thickness to which it has been ground; usually used as a highly stable control for transmitters and receivers (requires one crystal for each transmitting or receiving frequency)

E. FM (frequency modulation)--process by which the message signal is used to vary the frequency of the carrier signal

F. Modulation--process by which the message signal is used to vary some characteristic of a carrier signal, such as amplitude (AM) or frequency (FM)

G. PLL (phase-locked loop)--method of developing highly stable multiple frequencies for transmitters and receivers using relatively complex circuitry but only one crystal

H. RF (radio frequency)--frequencies usually considered to be between 150KHz and the infrared range

I. Transmitter--device that converts information (messages) into electrical signals which are sent by cable or through space from an antenna

II. AM and FM transmitter categories

A. Frequency generation techniques

1. Crystal-controlled oscillators
2. PLL-controlled oscillators
3. LC oscillators
4. RC oscillators

B. Modulation techniques

1. Amplitude modulation
2. Frequency modulation

III. Stages of typical transmitters (AM and FM) **(HO 1.1)**

A. Audio amplifier (intelligent "message" signal amplifier)

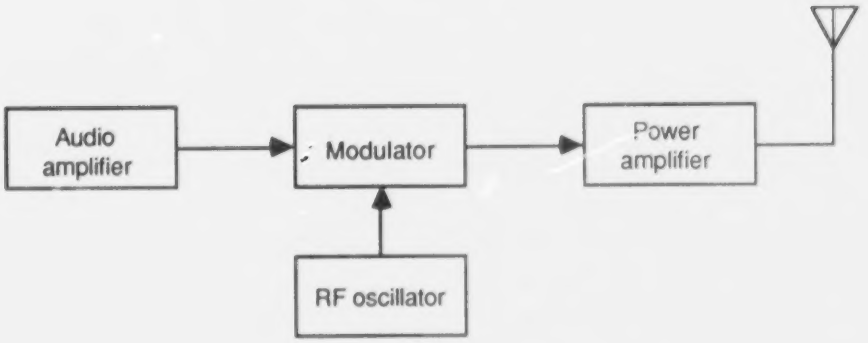
B. RF oscil[illegible]or/frequency multipliers

C. Modulator

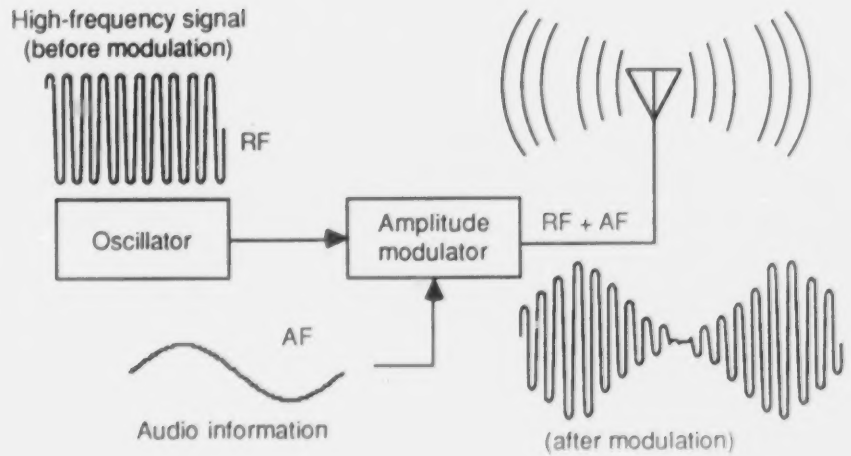
D. Power amplifier (class C)

TYPICAL TRANSMITTER

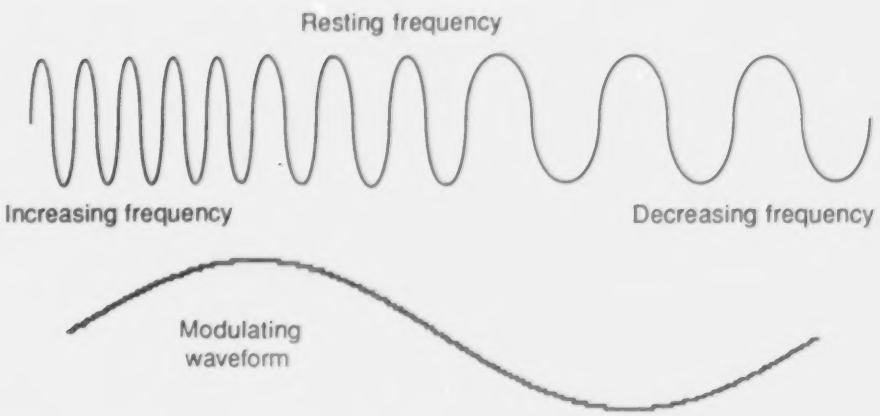
Typical transmitter



A simplified AM transmitter



Frequency modulation waveforms



MODULE: RECEIVERS AND TRANSMITTERS

UNIT I: AM/FM TRANSMITTER AND RECEIVER BASICS

LESSON 2: RECEIVERS

I. Terms and definitions

A. AFC (automatic frequency control)--circuit designed to keep the receiver's local oscillator frequency on track with the transmitted carrier so the receiver will not "drift" off frequency

B. AVC/AGC (automatic volume/gain control)--circuit designed to keep a receiver's output relatively constant when the received signal grows weaker or stronger

C. Detector--circuit where the input is a modulated IF and the output is the AF capable of being amplified and fed to a speaker

D. IF (intermediate frequency)--frequencies generated within a receiver that are produced by mixing two original frequencies. Typical IF frequencies are (AM) 455KHz, (FM) 10.7KHz and (TV) 42MHz.

E. Local oscillator frequency (also called injection oscillator)--the locally produced frequency (by either PLL, crystal or other tuned circuitry) that mixes with the incoming RF signal to produce the IF necessary for detection

F. Mixer--component or circuit containing a non-linear device capable of combining two input signals and producing four primary output signals

G. Receiver--electronic system that converts electrical signals from a carrier signal (via cable or antenna) into usable information (such as sound from a speaker or letters and numbers on a computer screen)

H. Selectivity--specification that relates to how well a receiver can receive one signal while rejecting others that may produce interference

I. Sensitivity--specification that relates to how well a receiver can pick up and use weakly received signals

J. Superhetradyne (superhet)--receiver that mixes (hetradynes) the frequency from the antenna and a local oscillator to produce an IF frequency

II. Stages of a typical receiver

A. RF amplifier: usually the first stage in a receiver; amplifies incoming RF signal; usually has an input tuned circuit and an output tuned circuit

B. Oscillator: in the tuning part of the receiver and sometimes part of the mixer stage; mixes with the incoming RF signal to develop an intermediate frequency

C. Mixer: part of a receiver's tuning section; mixes the RF signal with the oscillator signal to develop the IF signal; the first detector of the receiver's selectivity

D. IF amplifier: gives the receiver sensitivity in selecting RF signals. Most radios have two IF (intermediate frequency) stages of amplification.

E. Detector: separates audio information from the IF intermediate carrier

F. AF amplifier: output section of the receiver which drives the speakers; usually contains volume and tone controls; amplifies audio information out of the detector stage

G. Variable frequency divider: portion of some PLL circuits that causes different frequencies to be compared by the same phase detector

III. Mixers

A. Local oscillator (LO) frequency determined by desired radio frequency (RF) and the intermediate frequency (IF) built into the receiver

B. Mixer operation

1. Usually accomplished by a transistor

2. Accepts two input signals

3. Produces four output signals

a. The original two input frequencies

b. The sum of the original two input frequencies

c. The difference between the original two input frequencies

C. The output of the mixer stage is always the oscillator minus the RF frequency.

Example: An FM station broadcasting at 100MHz is picked up by a receiver that uses a 10.7MHz IF. The local oscillator can oscillate at: 100MHz + 10.7MHz = 110.7MHz

or

100MHz - 10.7MHz = 89.3MHz

Example: An AM radio receiver is capable of picking up signals from 535 to 1650KHz. The LO is set on 1165KHz and the receiver uses a 455KHz IF. The radio station this receiver is picking up is on: 1165KHz - 455KHz = 710KHz

or

1165KHz + 455KHz = 1620KHz (However, the sum is not generally used because the RF amplifier would be out of tune.)

D. IF (intermediate frequency) amplifier stage

1. Isolate the one IF frequency from the four output frequencies of the mixer stage (tuned LC or crystal filter components).

2. Amplify the IF signal to make up for losses that occur in the filtering section.

E. Detector stage

1. Detects the frequency rate of change for FM and provides an AF output

2. Detects the AM change of amplitude and provides an AF output

F. AF amplifier stage--same as typical AF amplifier from previous section

MODULE: RECEIVERS AND TRANSMITTERS

UNIT I: AM/FM TRANSMITTER AND RECEIVER BASICS

LESSON 3: PHASE-LOCKED LOOPS (PLL)

I. Terms and definitions

A. DC amplifier (error amplifier)--amplifier where the input is the low-pass filter's output. This circuit amplifies the magnitude of the signal that started in the phase detector. Its purpose is to amplify any error that may be found by the phase detector so that it can send a correcting voltage to the VCO.

B. Low-pass filter--designed to pass only low frequency or DC signals. The input to this device is the output of the phase detector.

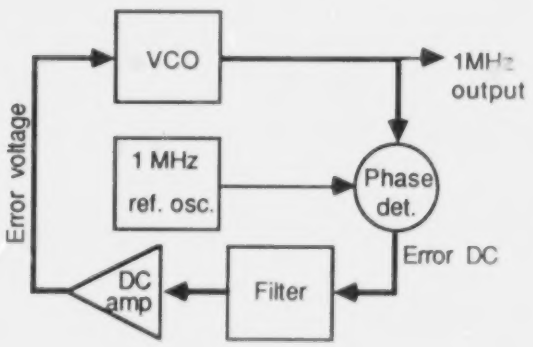
C. Phase detector--circuit that accepts two inputs and provides an output proportional to the degree that the two input signals are out of phase

D. Reference oscillator--highly stable oscillator used as the standard against which a sample of the output frequency is compared

E. VCO (voltage-controlled oscillator)--oscillator where the output frequency is directly proportional to the input DC (control) voltage

II. PLL circuit operations **(HO 3.1)**

A. The basic operation detects an error voltage between two frequencies where the difference is measured in degrees. The PLL then amplifies the error voltage to correct the frequency of the VCO (voltage-controlled oscillator).

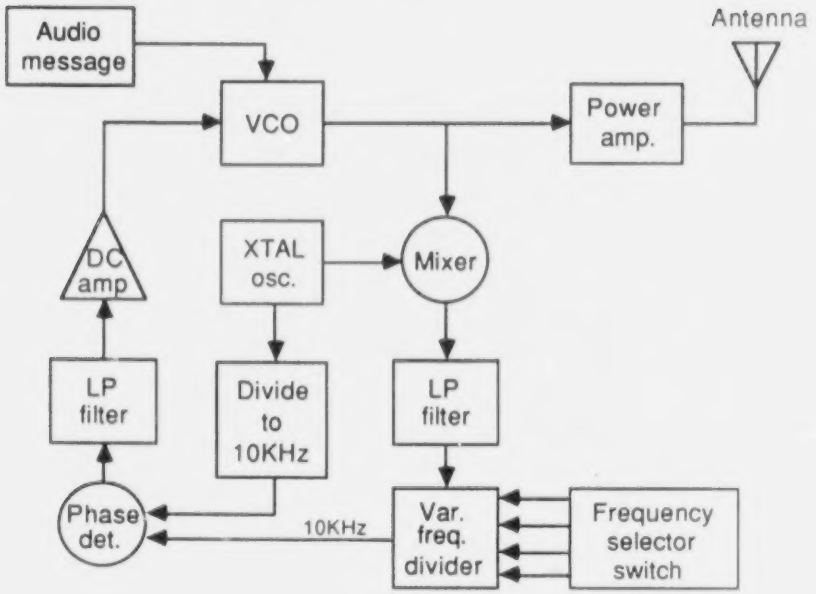


B. The two frequencies are either direct into the phase detector or are frequency divided down to the detector frequencies.

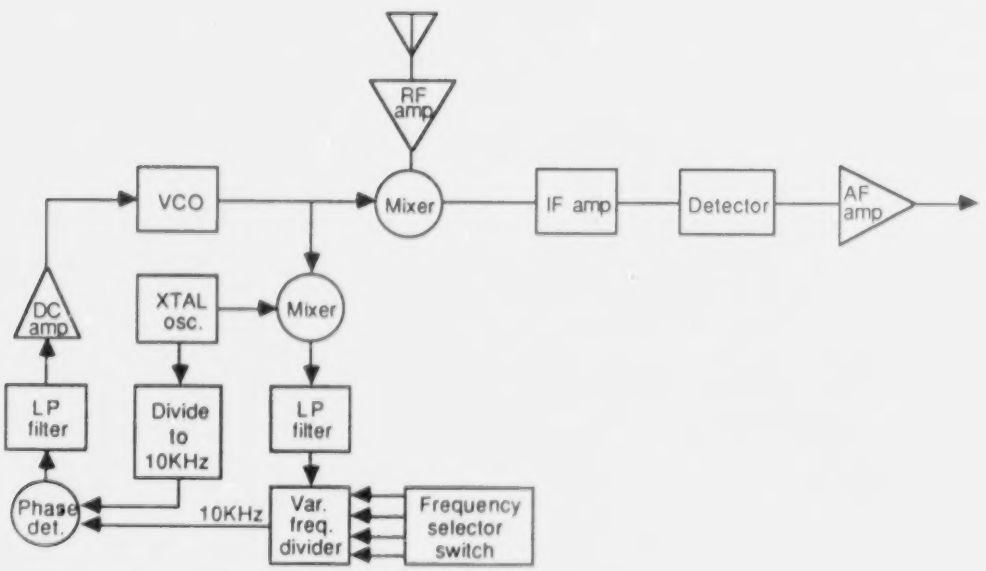
C. The PLL is a loop which begins with a VCO. It is then compared with a reference frequency in the phase detector. The error voltage is amplified and sent to correct the phase of the VCO.

PLL SYSTEMS

Typical transmitter PLL system



Typical Receiver PLL system



MOTOROLA FLOWCHART SUPPLEMENT

This handout contains troubleshooting charts for the following.

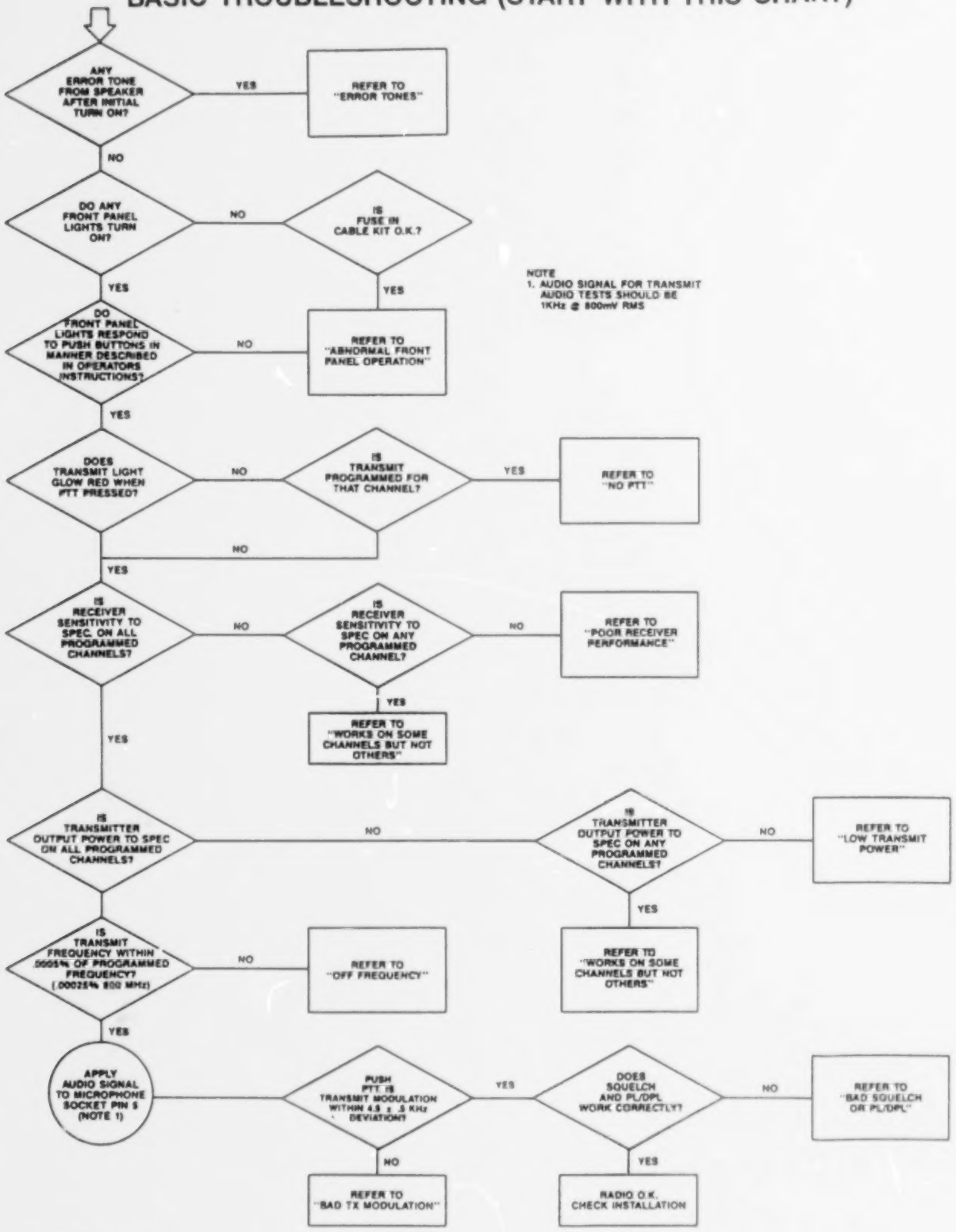
1. Basic troubleshooting
2. Poor receiver performance
3. Low transmitter power
4. Abnormal front panel operation
5. Nothing received at any RF level
6. No front panel lights
7. No PTT
8. Radio works on some channels but not others

Credit: RADIUS™ Service Manual (68-80101W58-A). Schaumburg, IL: Motorola, Inc., 1988.

Error tones

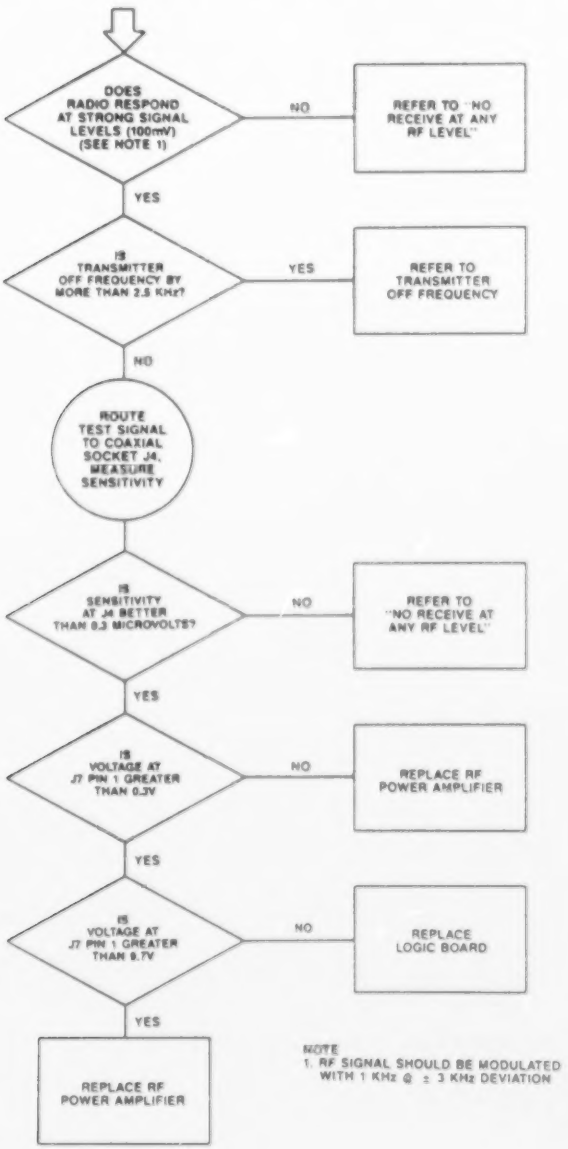
Tone	Problem
High-pitched beep (900Hz 119ms) on initial turn-on or when key is pressed	Normal operation--no error
Low-pitched tone (163Hz) for five seconds following turn-on	Code plug error. For all code plug errors, try to re-program the radio. If this does not clear the fault or if the problem recurs, replace the logic board.
Low-frequency (163Hz), continuous tone present whenever radio is on	Logic board failure. Replace logic board.
Low-pitched beep (300Hz 200ms) when a button is pressed	Button is not allowed in the current operating condition. Change operating condition--select another mode.
Low-frequency (150Hz or 112.5Hz), continuous tone while PTT is held	Transmitting is not allowed. If it was time-out-timer, release the PTT, then continue the call.

BASIC TROUBLESHOOTING (START WITH THIS CHART)


ANY ERROR TONE FROM SPEAKER AFTER INITIAL TURN ON?
YES
REFER TO "ERROR TONES"
NO
DO ANY FRONT PANEL LIGHTS TURN ON?
NO
IS FUSE IN CABLE KIT O.K.?
YES
YES
DO FRONT PANEL LIGHTS RESPOND TO PUSH BUTTONS IN MANNER DESCRIBED IN OPERATORS INSTRUCTIONS?
NO
REFER TO "ABNORMAL FRONT PANEL OPERATION"
YES
DOES TRANSMIT LIGHT GLOW RED WHEN PTT PRESSED?
NO
IS TRANSMIT PROGRAMMED FOR THAT CHANNEL?
YES
REFER TO "NO PTT"
NO
YES
IS RECEIVER SENSITIVITY TO SPEC. ON ALL PROGRAMMED CHANNELS?
NO
IS RECEIVER SENSITIVITY TO SPEC ON ANY PROGRAMMED CHANNEL?
NO
REFER TO "POOR RECEIVER PERFORMANCE"
YES
REFER TO "WORKS ON SOME CHANNELS BUT NOT OTHERS"
YES
IS TRANSMITTER OUTPUT POWER TO SPEC ON ALL PROGRAMMED CHANNELS?
NO
IS TRANSMITTER OUTPUT POWER TO SPEC ON ANY PROGRAMMED CHANNELS?
NO
REFER TO "LOW TRANSMIT POWER"
YES
REFER TO "WORKS ON SOME CHANNELS BUT NOT OTHERS"
IS TRANSMIT FREQUENCY WITHIN .0005% OF PROGRAMMED FREQUENCY? (.00025% 800 MHz)
NO
REFER TO "OFF FREQUENCY"
YES
APPLY AUDIO SIGNAL TO MICROPHONE SOCKET PIN 5 (NOTE 1)
PUSH PTT IS TRANSMIT MODULATION WITHIN 4.8 ± .5 KHz DEVIATION?
YES
DOES SQUELCH AND PL/DPL WORK CORRECTLY?
NO
REFER TO "BAD SQUELCH OR PL/DPL"
NO
REFER TO "BAD TX MODULATION"
YES
RADIO O.K. CHECK INSTALLATION

NOTE
1. AUDIO SIGNAL FOR TRANSMIT AUDIO TESTS SHOULD BE 1KHz @ 800mV RMS

POOR RECEIVER PERFORMANCE


DOES RADIO RESPOND AT STRONG SIGNAL LEVELS (100mV) (SEE NOTE 1)
NO
REFER TO "NO RECEIVE AT ANY RF LEVEL"
YES
IS TRANSMITTER OFF FREQUENCY BY MORE THAN 2.5 KHz?
YES
REFER TO TRANSMITTER OFF FREQUENCY
NO
ROUTE TEST SIGNAL TO COAXIAL SOCKET J4, MEASURE SENSITIVITY
IS SENSITIVITY AT J4 BETTER THAN 0.3 MICROVOLTS?
NO
REFER TO "NO RECEIVE AT ANY RF LEVEL"
YES
IS VOLTAGE AT J7 PIN 1 GREATER THAN 0.3V
NO
REPLACE RF POWER AMPLIFIER
YES
IS VOLTAGE AT J7 PIN 1 GREATER THAN 9.7V
NO
REPLACE LOGIC BOARD
YES
REPLACE RF POWER AMPLIFIER

NOTE
1. RF SIGNAL SHOULD BE MODULATED WITH 1 KHz @ ± 3 KHz DEVIATION

IMPORTANT

IF THE RF BOARD, LOGIC BOARD, OR RF POWER AMPLIFIER ARE REPLACED, RECALIBRATION OF THE RADIO MUST BE PERFORMED. REFER TO SECTION 6.

LOW TRANSMITTER POWER

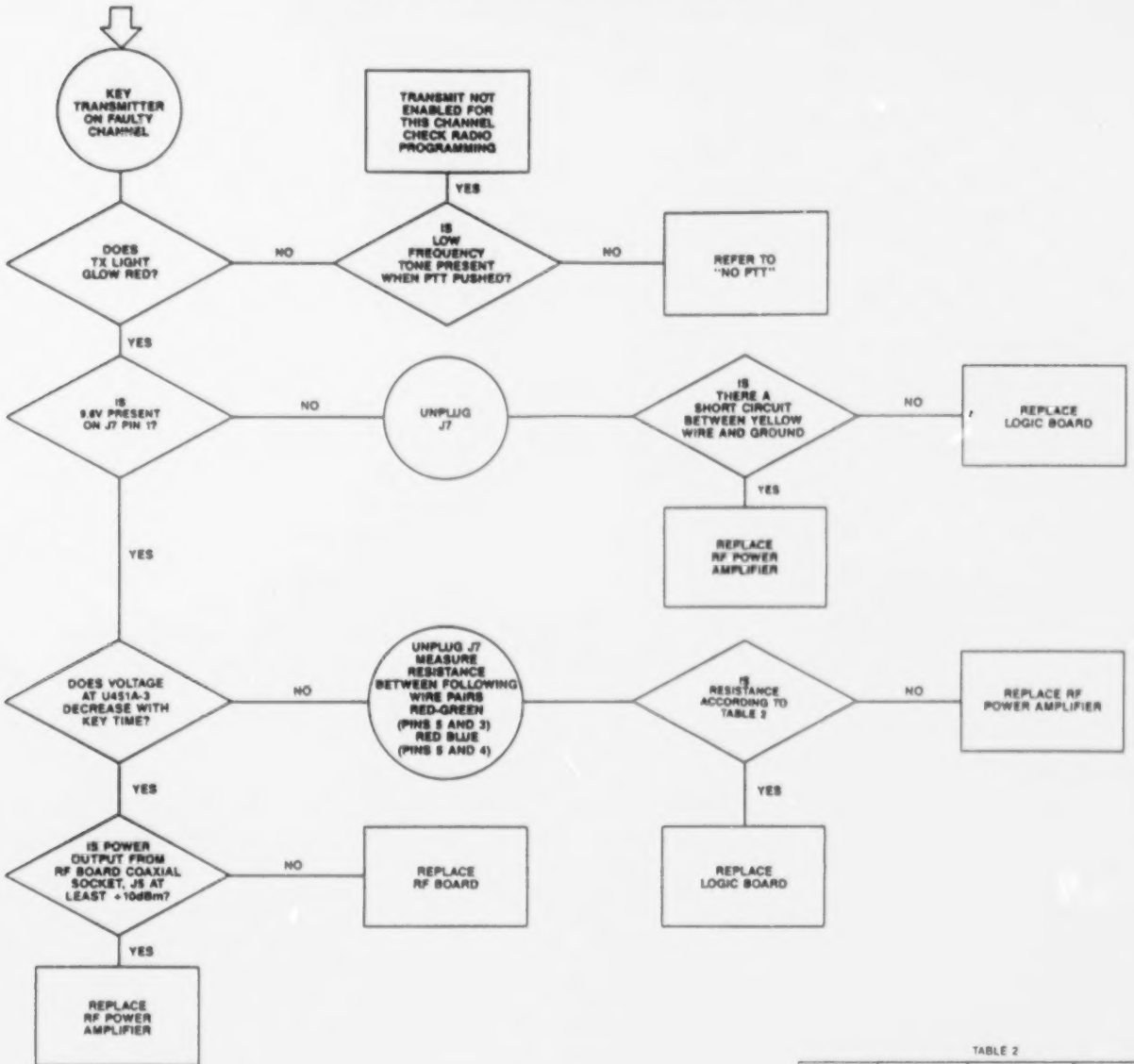

KEY TRANSMITTER ON FAULTY CHANNEL
TRANSMIT NOT ENABLED FOR THIS CHANNEL CHECK RADIO PROGRAMMING
YES
DOES TX LIGHT GLOW RED?
NO
IS LOW FREQUENCY TONE PRESENT WHEN PTT PUSHED?
NO
REFER TO "NO PTT"
YES
IS 9.6V PRESENT ON J7 PIN 1?
NO
UNPLUG J7
IS THERE A SHORT CIRCUIT BETWEEN YELLOW WIRE AND GROUND
NO
REPLACE LOGIC BOARD
YES
REPLACE RF POWER AMPLIFIER
YES
DOES VOLTAGE AT U451A-3 DECREASE WITH KEY TIME?
NO
UNPLUG J7 MEASURE RESISTANCE BETWEEN FOLLOWING WIRE PAIRS RED-GREEN (PINS 5 AND 3) RED BLUE (PINS 5 AND 4)
IS RESISTANCE ACCORDING TO TABLE 2
NO
REPLACE RF POWER AMPLIFIER
YES
IS POWER OUTPUT FROM RF BOARD COAXIAL SOCKET, J5 AT LEAST +10dBm?
NO
REPLACE RF BOARD
YES
REPLACE LOGIC BOARD
YES
REPLACE RF POWER AMPLIFIER

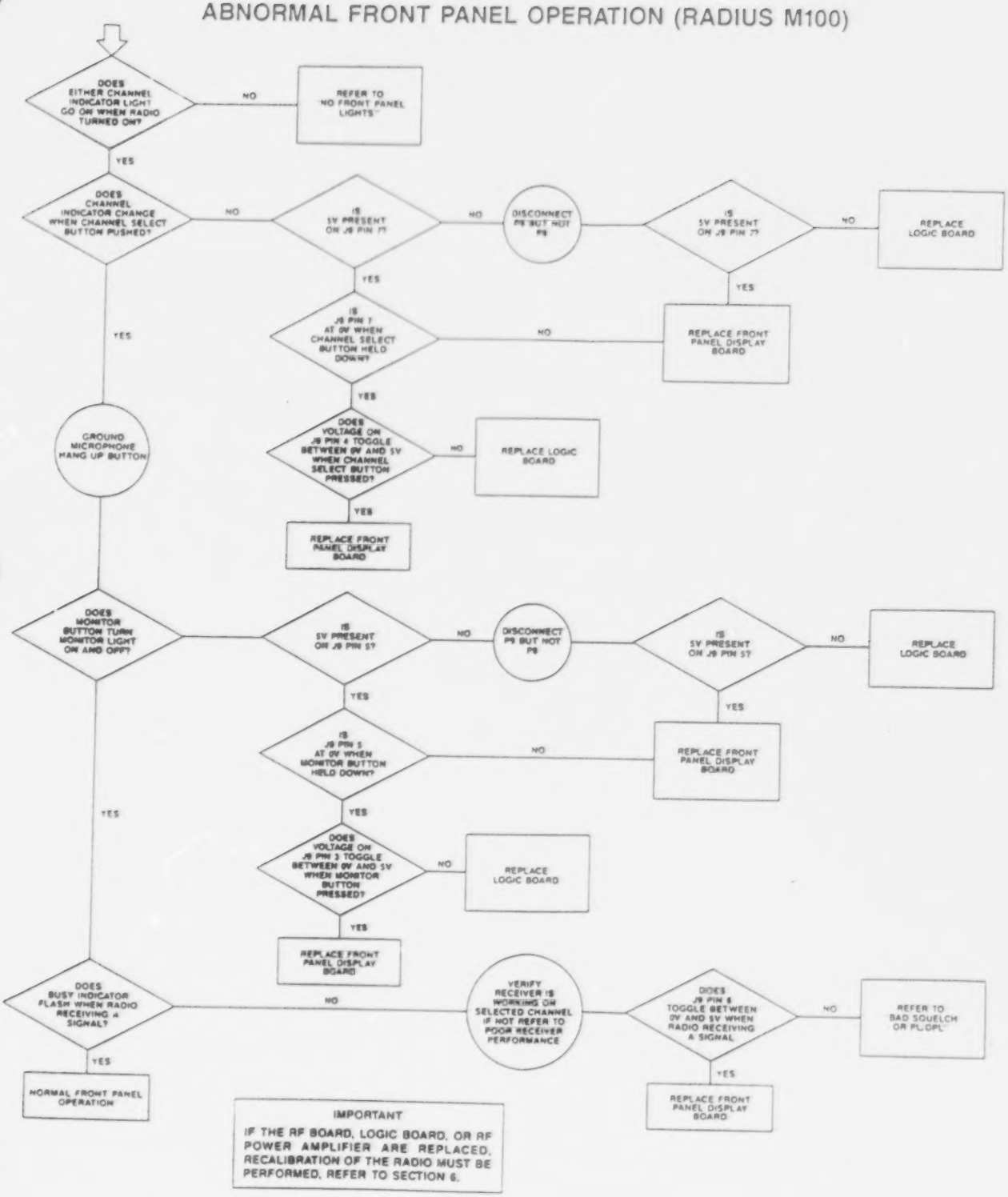
TABLE 2

BAND	POWER	WIRE PAIR	RESISTANCE
VHF	25W	RED-GREEN	43 OHMS
VHF	25W	RED-BLUE	005 OHMS
VHF	40W	RED-GREEN	15 OHMS
VHF	40W	RED-BLUE	001 OHMS
UHF	25W	RED-GREEN	39 OHMS
UHF	25W	RED-BLUE	005 OHMS
UHF	35W	RED-GREEN	12 OHMS
UHF	35W	RED-BLUE	001 OHMS
800	15W	RED-GREEN	39 OHMS
800	15W	RED-BLUE	005 OHMS

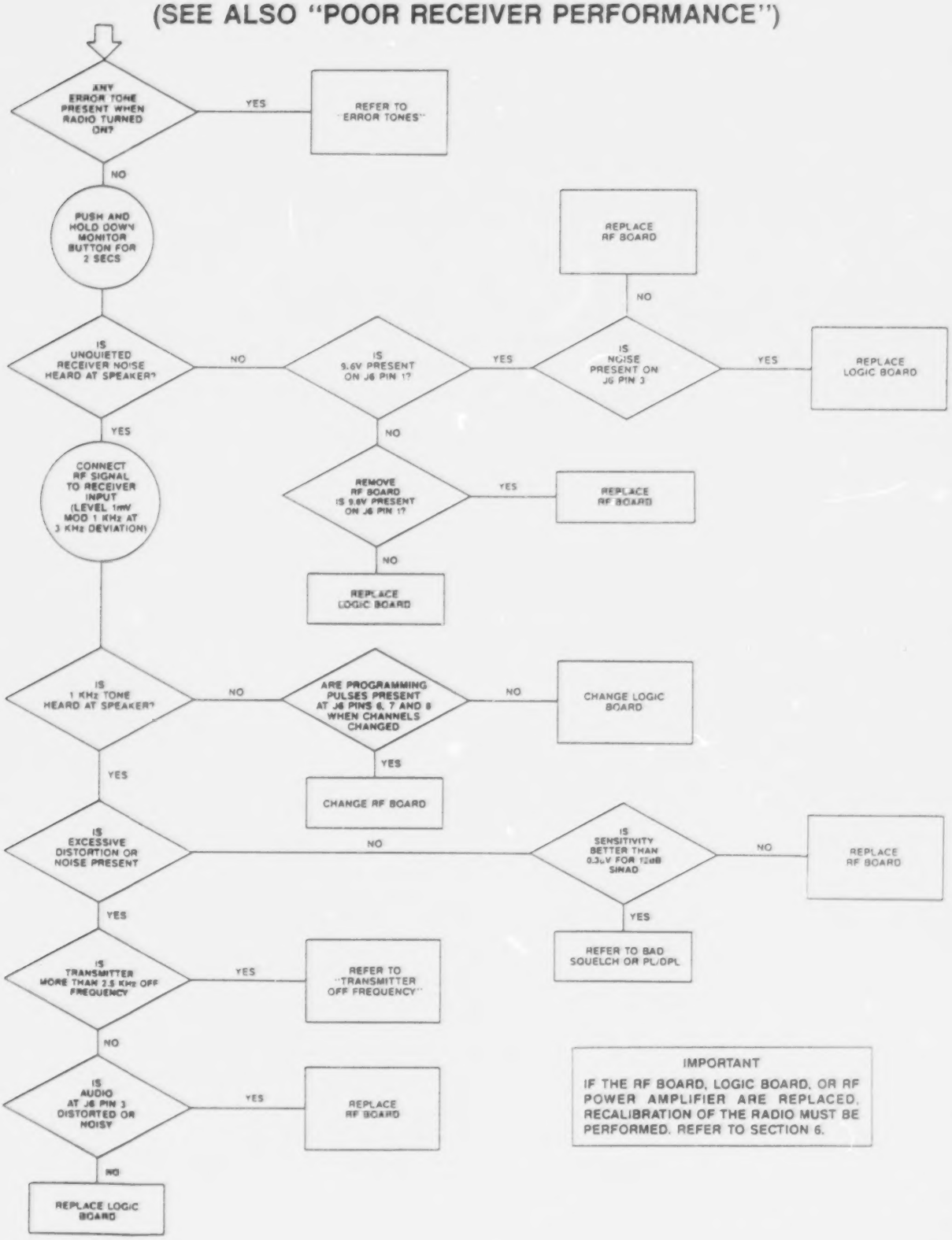
IMPORTANT

IF THE RF BOARD, LOGIC BOARD, OR RF POWER AMPLIFIER ARE REPLACED, RECALIBRATION OF THE RADIO MUST BE PERFORMED. REFER TO SECTION 6.

ABNORMAL FRONT PANEL OPERATION (RADIUS M100)


DOES EITHER CHANNEL INDICATOR LIGHT GO ON WHEN RADIO TURNED ON?
NO
REFER TO NO FRONT PANEL LIGHTS
YES
DOES CHANNEL INDICATOR CHANGE WHEN CHANNEL SELECT BUTTON PUSHED?
NO
IS 5V PRESENT ON J9 PIN 7?
NO
DISCONNECT P9 BUT NOT P8
IS 5V PRESENT ON J9 PIN 7?
NO
REPLACE LOGIC BOARD
YES
REPLACE FRONT PANEL DISPLAY BOARD
YES
IS J9 PIN 7 AT 0V WHEN CHANNEL SELECT BUTTON HELD DOWN?
NO
YES
DOES VOLTAGE ON J9 PIN 4 TOGGLE BETWEEN 0V AND 5V WHEN CHANNEL SELECT BUTTON PRESSED?
NO
REPLACE LOGIC BOARD
YES
REPLACE FRONT PANEL DISPLAY BOARD
YES
GROUND MICROPHONE HANG UP BUTTON
DOES MONITOR BUTTON TURN MONITOR LIGHT ON AND OFF?
IS 5V PRESENT ON J9 PIN 5?
NO
DISCONNECT P9 BUT NOT P8
IS 5V PRESENT ON J9 PIN 5?
NO
REPLACE LOGIC BOARD
YES
REPLACE FRONT PANEL DISPLAY BOARD
YES
IS J9 PIN 5 AT 0V WHEN MONITOR BUTTON HELD DOWN?
NO
YES
DOES VOLTAGE ON J9 PIN 3 TOGGLE BETWEEN 0V AND 5V WHEN MONITOR BUTTON PRESSED?
NO
REPLACE LOGIC BOARD
YES
REPLACE FRONT PANEL DISPLAY BOARD
YES
DOES BUSY INDICATOR FLASH WHEN RADIO RECEIVING A SIGNAL?
NO
VERIFY RECEIVER IS WORKING ON SELECTED CHANNEL IF NOT REFER TO POOR RECEIVER PERFORMANCE
DOES J9 PIN 6 TOGGLE BETWEEN 0V AND 5V WHEN RADIO RECEIVING A SIGNAL
NO
REFER TO BAD SQUELCH OR PL/DPL
YES
REPLACE FRONT PANEL DISPLAY BOARD
YES
NORMAL FRONT PANEL OPERATION
IMPORTANT
IF THE RF BOARD, LOGIC BOARD, OR RF POWER AMPLIFIER ARE REPLACED, RECALIBRATION OF THE RADIO MUST BE PERFORMED. REFER TO SECTION 6.

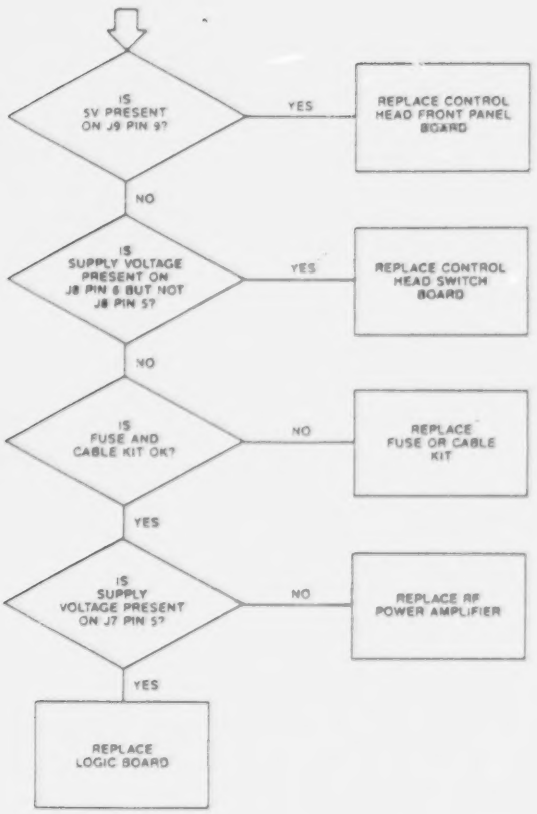
NO RECEIVE AT ANY RF LEVEL
(SEE ALSO "POOR RECEIVER PERFORMANCE")



IMPORTANT

IF THE RF BOARD, LOGIC BOARD, OR RF POWER AMPLIFIER ARE REPLACED, RECALIBRATION OF THE RADIO MUST BE PERFORMED. REFER TO SECTION 6.

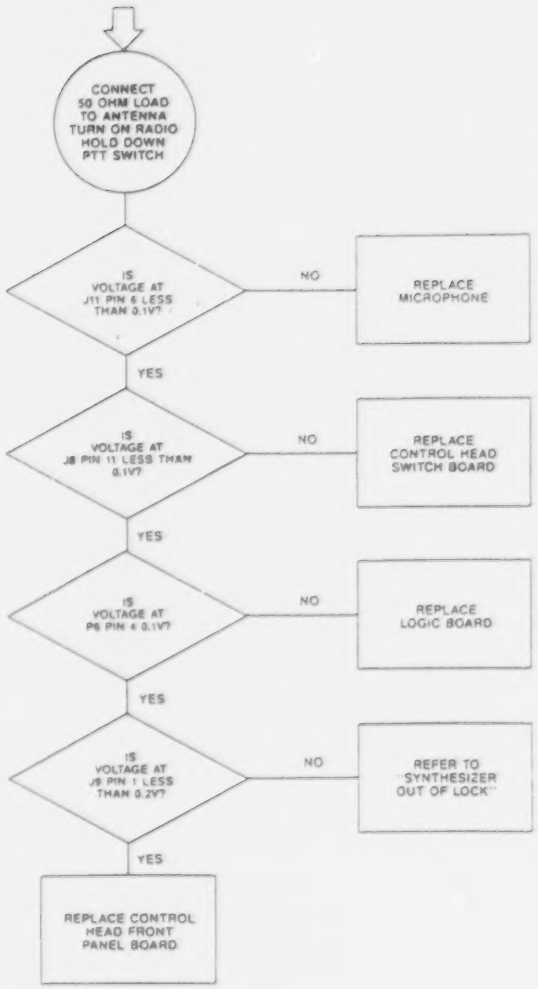
NO FRONT PANEL LIGHTS (RADIUS M100)



IMPORTANT

IF THE RF BOARD, LOGIC BOARD, OR RF POWER AMPLIFIER ARE REPLACED, RECALIBRATION OF THE RADIO MUST BE PERFORMED. REFER TO SECTION 6.

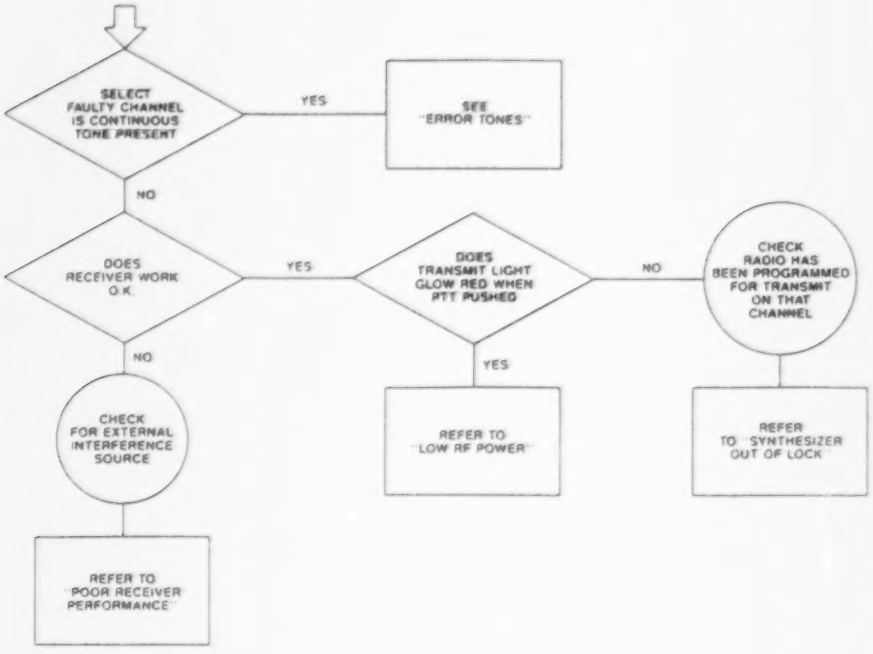
NO PTT


CONNECT 50 OHM LOAD TO ANTENNA TURN ON RADIO HOLD DOWN PTT SWITCH
IS VOLTAGE AT J11 PIN 6 LESS THAN 0.1V?
NO
REPLACE MICROPHONE
YES
IS VOLTAGE AT J8 PIN 11 LESS THAN 0.1V?
NO
REPLACE CONTROL HEAD SWITCH BOARD
YES
IS VOLTAGE AT P6 PIN 4 0.1V?
NO
REPLACE LOGIC BOARD
YES
IS VOLTAGE AT J9 PIN 1 LESS THAN 0.2V?
NO
REFER TO "SYNTHESIZER OUT OF LOCK"
YES
REPLACE CONTROL HEAD FRONT PANEL BOARD

IMPORTANT

IF THE RF BOARD, LOGIC BOARD, OR RF POWER AMPLIFIER ARE REPLACED, RECALIBRATION OF THE RADIO MUST BE PERFORMED. REFER TO SECTION 6.

RADIO WORKS ON SOME CHANNELS BUT NOT OTHERS

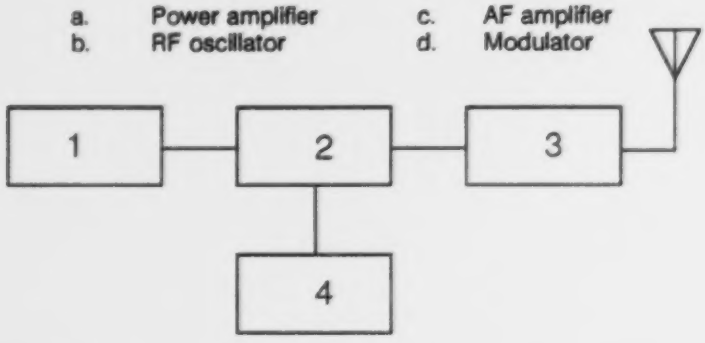


TRANSMITTER AND RECEIVER PRACTICE

For questions 1-4, match parts of the simplified transmitter block diagram shown below to the numbers.

___ 1.
___ 2.
___ 3.
___ 4.

a. Power amplifier
b. RF oscillator
c. AF amplifier
d. Modulator



___ 5. A radio's LO is oscillating at 1135KHz. The IF of the radio is 455KHz. If the band of the radio is 535-1650KHz, the radio station picked up by the radio is broadcasting on a frequency of _____ KHz.

___ 6. Draw an unmodulated carrier wave.

___ 7. Draw an AM modulated carrier wave.

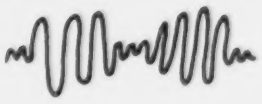
___ 8. Draw an FM modulated carrier wave.

___ 9. A radio receives an FM station at 93MHz and its LO is on 103.7MHz. List the four output frequencies of the mixer stage.

a.
b.
c.
d.

___ 10. Most modern receivers and transmitters depend upon a component called the _____ to maintain very stable oscillations.

ANSWERS TO AS 3.1

1. c
2. d
3. a
4. b
5. 680KHz
6.
7. 
8.
9. a. 93MHz
   b. 103.7MHz
   c. 10.7MHz (This is also the typical FM IF.)
   d. 196.7MHz
10. Crystal

MODULE: RECEIVERS AND TRANSMITTERS

UNIT I: AM/FM TRANSMITTER AND RECEIVER BASICS

UNIT TEST

Match the following terms and definitions.

____	1.	Circuit that accepts two inputs and provides an output proportional to how much the inputs are out of phase	a. AF
____	2.	Device that converts information (messages) into electrical signals which are sent by cable or through space from an antenna	b. AM
____	3.	Frequencies usually considered to be between 150KHz and the infrared range	c. AVC/AGC
____	4.	Frequencies generated within a receiver that are produced by mixing two original frequencies	d. Crystal
____	5.	Oscillator where the output frequency is directly proportional to the input DC (control) voltage	e. DC amplifier
____	6.	Piezoelectric device that oscillates at a frequency determined by the thickness to which it has been ground	ab. Detector
____	7.	Process by which the message signal is used to vary some characteristic of a carrier signal, such as AM or FM	ac. FM
____	8.	Frequencies within the range of human hearing; usually considered to be approximately 20-20,000Hz (20KHz)	ad. IF
____	9.	Process by which the message signal is used to vary the frequency of the carrier signal	ae. Mixer
____	10.	Process by which the message signal is used to vary the amplitude of the carrier signal	bc. Modulation
			bd. Phase detector
			be. Receiver
			cd. RF
			ce. Transmitter
			de. VCO

Select the option which answers the question or completes the statement.

____ 11. A local oscillator is tuned to 106.7MHz, and the IF of this receiver is 10.7MHz. What is the frequency received by this radio?

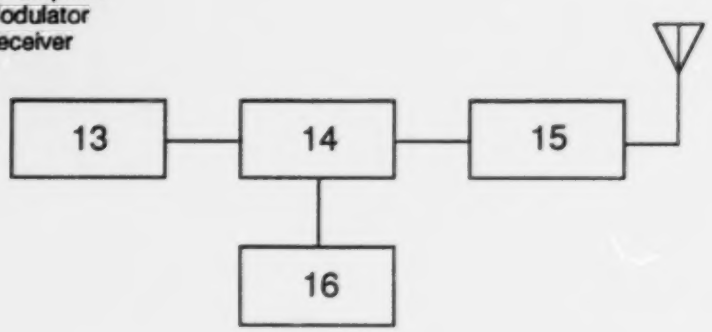
a. 100MHz
b. 86MHz
c. 96MHz
d. 106MHz
e. 112MHz

____ 12. An AM receiver is tuned to pick up a radio station broadcasting on 610KHz. The IF of the radio is 455KHz. At what setting should the LO oscillate?

a. 1065KHz
b. 965KHz
c. 610KHz
d. 325KHz
e. 116KHz

For 13-16, use the following terms to identify the numbered components.

a. Power amplifier
b. RF oscillator
c. AF amplifier
d. Modulator
e. Receiver

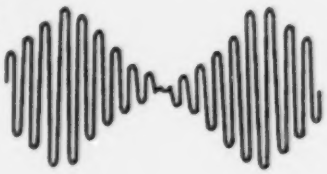


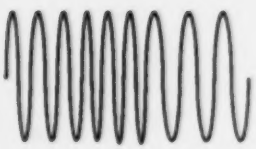
___ 13.
___ 14.
___ 15.
___ 16.

Select the option which answers the question or completes the statement.

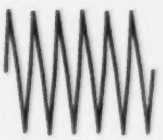
___ 17. Of the waveforms below, which represents AM?

a.

b.


c.


d.

e.


___ 18. Of the waveforms, which represents FM?

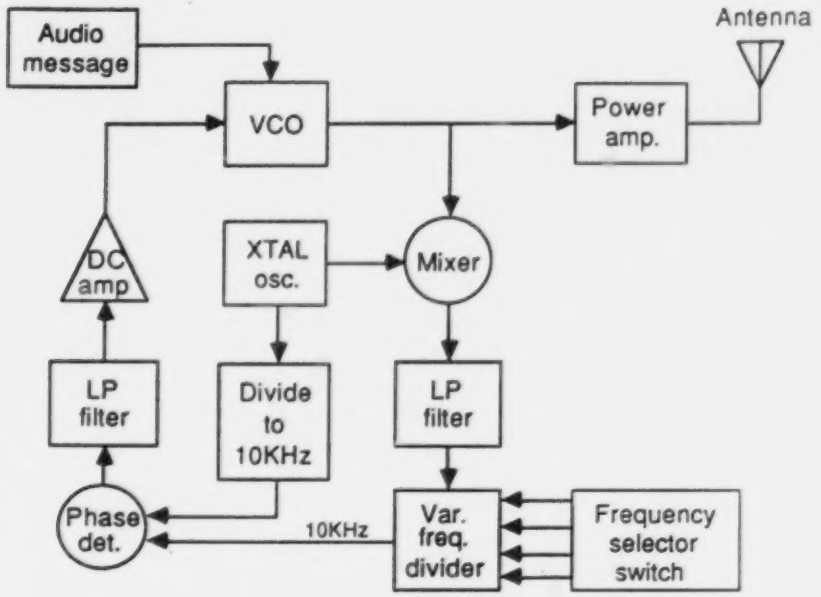
___ 19. Which type of receiver uses only one crystal for many different channels or frequencies?

a. AFC
b. LO
c. PLL
d. RF
e. Superhet

___ 20. A mixer has two frequencies for the input. How many frequencies make up its output?

a. 0
b. 2
c. 3
d. 4
e. 5

___ 21. In a PLL circuit such as the following one, the frequency selector switch divides the frequency by 460 times. The frequency of the crystal oscillator is 40MHz. What is the output frequency of the VCO?



a. 4460MHz
b. 446MHz
c. 46MHz
d. 44.6MHz
e. .46MHz

ANSWERS TO UNIT TEST

1.	bd	(G1)	12.	a	(F3)
2.	ce	(G2)	13.	c	(G2)
3.	cd	(G1)	14.	d	(G2)
4.	ad	(G1)	15.	a	(G2)
5.	de	(G1)	16.	b	(G2)
6.	d	(G1)	17.	b	(G1)
7.	bc	(G2)	18.	c	(G1)
8.	a	(G1)	19.	c	(F3)
9.	ac	(G2)	20.	d	(G1)
10.	b	(G2)	21.	d	(F3)
11.	c	(G1)			

MODULE: RECEIVERS AND TRANSMITTERS

UNIT II: SATELLITE SYSTEMS, ANTENNAS AND ANALYZERS

UNIT OBJECTIVE

Upon completion of this unit the student should be able to describe the basic operation of microwave and satellite systems, the operation of transmitter and receiver antennas, and the function and application of the spectrum analyzer. This knowledge will be evidenced by achieving the specified score on the unit test.

SPECIFIC OBJECTIVES

After completion of the lessons in this unit, the student should be able to:

1.1 Define terms used when describing microwave and satellite communication systems.

1.2 Describe microwave and satellite communications systems. (competency G3)

2.1 Define terms used when describing the operation of transmitter and receiver antennas.

2.2 Describe the operation of transmitter and receiver antennas. (competency G4)

3.1 Define terms used when describing the function and application of the spectrum analyzer.

3.2 Describe the function and application of the spectrum analyzer. (partial competency H5)

MODULE: RECEIVERS AND TRANSMITTERS

UNIT II: SATELLITE SYSTEMS, ANTENNAS AND ANALYZERS

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Notes to the instructor

D. Lesson plans

1. Lesson 1: MICROWAVE AND SATELLITE SYSTEMS

   a. Information outline

   b. Handout

      HO 1.1: Antennas

2. Lesson 2: ANTENNA SYSTEMS

   a. Information outline

3. Lesson 3: SPECTRUM ANALYZERS

   a. Information outline

   b. Handout

      HO 3.1: Spectrum analyzer

   c. Assignment sheet

      AS 3.1: Satellites, antennas and analyzers

   d. Answers to assignment sheet

E. Unit test

F. Answers to unit test

REFERENCES

A. Books

1. Adamson, Thomas A. Electronic Communication Systems and Circuits. Albany, NY: Delmar, 1988.

2. Douglas-Young, John. Illustrated Encyclopedic Dictionary of Electronics. West Nyack, NY: Parker Publishing Co., Inc., 1981.

3. Graf, Rudolf F. Modern Dictionary of Electronics. 5th ed. Indianapolis, IN: Howard W. Sams & Co., Inc., 1977.

4. Schuler, Charles A. Electronics: Principles and Applications. 3rd ed. New York: McGraw-Hill, 1989.

B. Curriculum guide

1. Willison, Neil L., and James K. Shelton. Basic Electronics II. Stillwater, OK: Mid-America Vocational Curriculum Consortium, 1981.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. First-hand experience with satellite systems and/or other antenna systems may be difficult to give students. However, most radio stations, even low-power ones, can provide examples of dish antennas used for their network feeds.

2. Most parking lots have examples of CB radios and regular car-radio whip and embedded windshield antennas.

B. Suggested supplemental materials

1. AARL Handbook for the Radio Amateur. Newington, CT: The Amateur Radio Relay League, 1990. (published annually)

MODULE: RECEIVERS AND TRANSMITTERS

UNIT II: SATELLITE SYSTEMS, ANTENNAS AND ANALYZERS

LESSON 1: MICROWAVE AND SATELLITE SYSTEMS

I. Terms and definitions

A. Footprint--area of the earth that can receive signals from a satellite in geosynchronous orbit

B. Geosynchronous orbit--the orbit that standard earth communications satellites use 22,300 miles above the earth's surface and directly over the Equator. In that location, the satellites stay in one place relative to the earth's surface.

C. Horn--antenna element that actually sends or receives the signal to or from the parabolic reflector

D. Line of sight--a direct line that microwave frequencies travel from one location to another. The signals will not "bend" around the earth. This requires that antennas be high and that antennas be placed no further apart than the curve of the earth will allow.

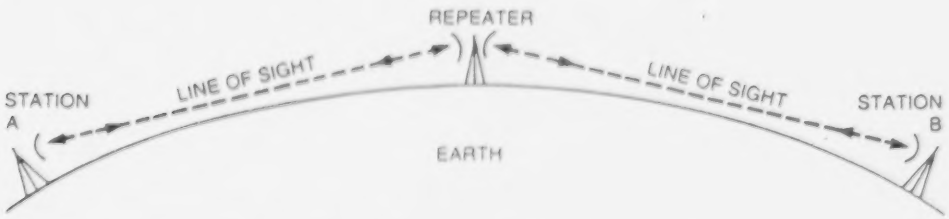
E. Microwave--generally signals from 1GHz (1 billion Hz) and up

F. Parabolic reflector (dish)--dish-shaped antenna that accepts all signals arriving perpendicular to the rim of the antenna and reflects them to a single point (focus) where the transmitting or receiving element of the system is located. This provides a highly concentrated signal (i.e. high gain) and is frequently used for microwave transmissions.

G. Waveguide--typically a rectangular metal box or round metal tubing, hollow on the inside, used for carrying microwave signals from one location to another (e.g. from a transmitter amplifier to an antenna); used in place of coaxial or twin lead cable because it is more efficient and loses less of the signal

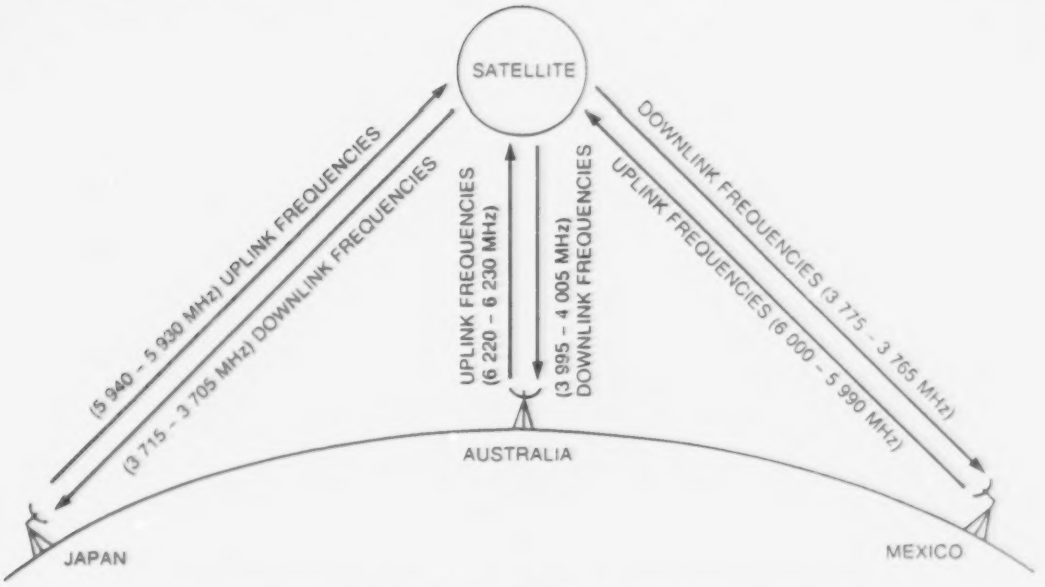
II. Microwave and satellite systems

A. Typical microwave system



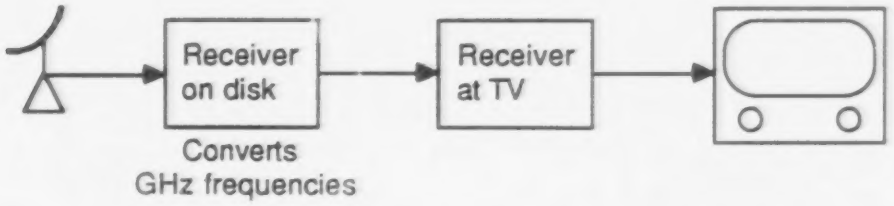
Credit: Adamson, Thomas A. Electronic Communications. Englewood Cliffs, NJ: Delmar, 1988. Reproduced by permission.

B. Typical satellite system


SATELLITE
(5 940 - 5 930 MHz) UPLINK FREQUENCIES
(3 715 - 3 705 MHz) DOWNLINK FREQUENCIES
UPLINK FREQUENCIES (6 220 - 6 230 MHz)
(3 995 - 4 005 MHz) DOWNLINK FREQUENCIES
DOWNLINK FREQUENCIES (3 775 - 3 765 MHz)
UPLINK FREQUENCIES (6 000 - 5 990 MHz)
AUSTRALIA
JAPAN
MEXICO

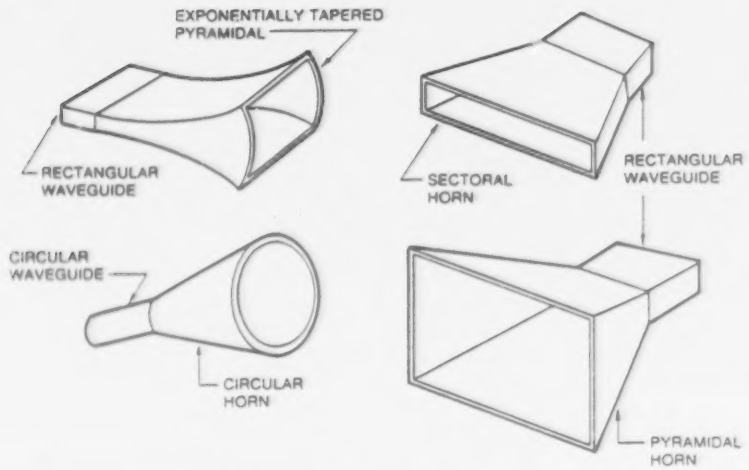
Credit: Adamson's Electronic Communications. Reproduced by permission.

C. Typical satellite-to-TV block diagram

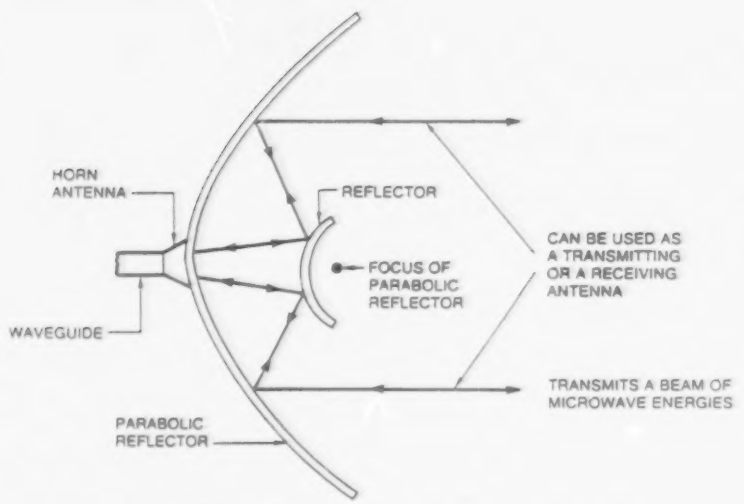


D. Steps of procedure to set up and site-in a satellite dish are dependent on manufacturer recommendations.

ANTENNAS



Typical horn antennas



Microwave parabolic antenna

Credit: Adamson, Thomas A. Electronic Communication Systems and Circuits. Albany, NY: Delmar, 1988, pg. 362. Reproduced by permission.

MODULE: RECEIVERS AND TRANSMITTERS

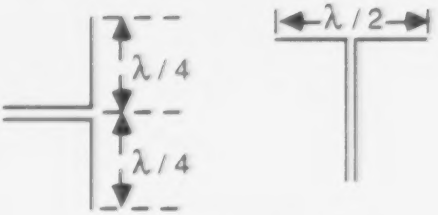
UNIT II: SATELLITE SYSTEMS, ANTENNAS AND ANALYZERS

LESSON 2: ANTENNA SYSTEMS

I. Terms and definitions

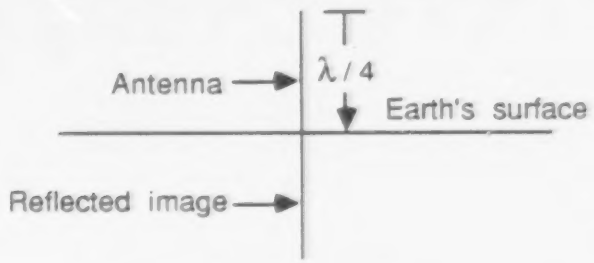
A. Antenna--component of a transmitter or receiver system that transforms electrical signals into electromagnetic waves capable of being transmitted through air and space. The antenna acts as an impedance device matching the nominal impedance of the transmitter or receiver to that of the air.

B. Wavelength--distance between two peaks (or any two corresponding points) of a wave



Hertz antenna

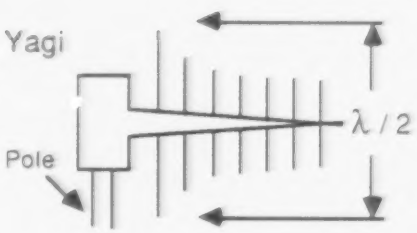
C. Hertz antenna--antenna that is one-half wavelength-long; also called the half-wave and dipole antenna



Marconi antenna

D. Marconi antenna--antenna that is one-quarter wavelength long; also called the grounded and whip antenna

E. Yagi antenna--type of directional Hertz antenna that uses additional antenna rods to "direct" and "reflect" the signal toward (when transmitting) or from (when receiving) one particular direction



Yagi antenna

II. Antenna system operation

A. Hertz, Marconi or Yagi antennas used by base-station antennas

B. Antenna types

1. Two-way radio antennas and car-radio antennas are Marconi antennas to take advantage of their shorter length. If too long, the vertical "whip" (hence their alternate name) can strike overpasses and low-hanging objects. (See the example of CB whips below).

2. Commercial FM and TV receivers are tuned best on Hertz or Yagi antennas.

C. Antenna length calculations

1. Wavelength = $\frac{\text{velocity of light}}{\text{frequency}}$ $(\lambda = c / f)$

where λ = length of wave in meters, c = velocity of light (in meters per second) and f = frequency of wave

2. Divide calculated wavelength by two for a Hertz antenna or by four for the Marconi antenna.

Examples:

Length of an FM station Hertz antenna at 100MHz

$\lambda = c / f$

$\lambda = \frac{3 * 10^8}{100 * 10^6}$

λ = 3 meters (approximately 10 ft. or 39.37")

Length of the antenna = $\lambda / 2$ = 1.5m or 5ft.

This is approximately the length (tip-to-tip) of the antennas in automobile windshields.

Length of an AM station Marconi antenna at 710KHz

$\lambda = c / f$

$\lambda = \frac{3 * 10^8}{710 * 10^3}$

λ = 422.5 meters (approximately 1408 ft.)

Length of the antenna = $\lambda / 4$ = 105.6m or 352ft.

The tower is the antenna. It is mounted on an insulating pad and the guy wires are connected with insulators.

Length of a CB whip antenna for a car

NOTE: CB frequencies are approximately 37MHz. A whip antenna is a Marconi antenna.

$\lambda = c / f$

$\lambda = \frac{3 * 10^8}{37 * 10^6}$

λ = 9.59 meters (approximately 27 ft.)

Length of the antenna = $\lambda / 4$ = approximately 7 ft.

MODULE: RECEIVERS AND TRANSMITTERS

UNIT II: SATELLITE SYSTEMS, ANTENNAS AND ANALYZERS

LESSON 3: SPECTRUM ANALYZERS

I. Terms and definitions

A. Federal Communications Commission (FCC)--government agency assigned the task of keeping users of radio frequencies from interfering with each other

B. Frequency domain--position of the beam of a spectrum analyzer travelling horizontally across the screen; controlled by the (changing) frequency of the receiving circuit

C. Spectrum analyzer--instrument with a display that indicates the magnitude or strength of a signal (shown as a vertical beam) and the frequency of a signal (horizontal beam)

D. Time domain--position of the beam of an oscilloscope travelling horizontally across the screen; controlled by time per division (e.g. ms per division)

II. Function and applications of a spectrum analyzer

A. Function

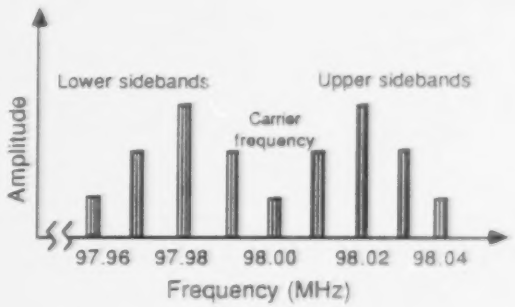
1. The spectrum analyzer displays a relative magnitude of any frequency it is capable of receiving.

2. See the example display below.

B. Applications

1. All transmitters dispatch signals not only on their own frequency but on other unauthorized frequencies as well.

2. The FCC, manufacturers of the radios and service technicians use spectrum analyzers to determine if the unauthorized frequencies are low enough in power to meet the limits set by the FCC's rules and regulations.



SPECTRUM ANALYZER

Example 1

A spectrum analyzer displays the information in Figure 3-17. (A) How many different sine waves are present? (B) Which sine wave has the greatest amplitude? (C) Which sine wave has the smallest amplitude?

Figure 3-17

Solution

Each frequency division is in megahertz. The voltage division is in millivolts.

(A) There are three different sine waves indicated by the display: 4 MHz, 6.5 MHz, and 8 MHz.

(B) The 6.5-MHz sine wave has the greatest voltage—6 mV.

(C) The 4-MHz sine wave has the smallest amplitude—2 mV.

Credit: Adamson, Thomas A. Electronic Communication Systems and Circuits. Albany, NY: Delmar, 1988, pg. 60. Reproduced by permission.

SATELLITES, ANTENNAS AND ANALYZERS

Match the following terms and definitions.

___ 1. Antenna element that actually sends or receives the signal to or from the parabolic reflector

___ 2. Component of a transmitter or receiver system that transforms electrical signals into electromagnetic waves capable of being transmitted through air and space

___ 3. Antenna that is one-half wavelength-long; also called the half-wave and dipole antenna

___ 4. Antenna that is one-quarter wavelength long; also called the grounded and whip antenna

___ 5. Instrument with a display that indicates the strength of a signal (shown by a vertical beam) and the frequency of a signal (horizontal beam)

a. Antenna
b. Hertz
c. Horn
d. Marconi
e. Parabolic reflector
ab. Spectrum analyzer
ac. Yagi

Select the option which answers the question or completes the statement.

___ 6. What is the type of antenna used by two-way radios?

a. Hertz
b. Marconi
c. Flat
d. None of the above

___ 7. Approximately how long is a Hertz antenna for a radio station broadcasting at 98MHz?

a. 2 ft.
b. 3 ft.
c. 5 ft.
d. 10 ft.

___ 8. Approximately how many feet in length is a Marconi antenna for a radio station broadcasting at 150MHz?

a. 1.64
b. 2
c. 3.27
d. 6.54

___ 9. What kind of antenna is usually installed on the roof of houses in the fringe area for better television reception?

a. Hertz
b. Marconi
c. Flat
d. None of the above

___ 10. What kind of antenna is a whip antenna?

a. Hertz
b. Marconi
c. Flat
d. None of the above

ANSWERS TO AS 3.1

1. c
2. a
3. b
4. d
5. ab
6. b
7. c
8. a
9. a
10. b

MODULE: RECEIVERS AND TRANSMITTERS

UNIT II: SATELLITE SYSTEMS, ANTENNAS AND ANALYZERS

UNIT TEST

Match the following terms and definitions.

____ 1.	Generally signals from 1GHz (1 billion Hz) and up	a.	Footprint
____ 2.	The orbit that standard earth communications satellites use 22,300 miles above the earth's surface and directly over the Equator	b.	Frequency domain
		c.	Geosynchronous
____ 3.	A direct line that microwave frequencies travel requiring that antennas be high and that antennas be placed no further apart than the curve of the earth will allow	d.	Line of sight
		e.	Microwave
____ 4.	Area of the earth that can receive signals from a satellite in geosynchronous orbit	ab.	Time domain
		ac.	Waveguide
____ 5.	Distance between two peaks (or any two corresponding points) of a wave	ad.	Wavelength
____ 6.	Position of the beam of an oscilloscope travelling horizontally across the screen		

Select the option which answers the question or completes the statement.

____ 7. Which antenna type uses the tower as its antenna?

a. Hertz
b. Marconi
c. Flat
d. Oblong
e. None of the above

____ 8. Which best describes a Hertz antenna?

a. A whip antenna
b. FM antenna used in stereos
c. Half the length of a Marconi antenna
d. All of the above
e. None of the above

____ 9. Approximately how many feet in length is a Hertz antenna for a radio station broadcasting at 115MHz?

a. 2
b. 4
c. 8
d. 10
e. 23

___ 10. Approximately how many feet in length is a Hertz antenna for a radio station broadcasting at 1600KHz?

a. 154
b. 188
c. 307
d. 504
e. 614

___ 11. Which describes a Yagi antenna?

a. Type of Hertz antenna
b. Type of Marconi antenna
c. Type of whip antenna
d. Duo-directional
e. Uni-directional

___ 12. What kind of orbit is represented by satellites that stay in the same place relative to the earth's surface?

a. Synchronized
b. Geosynchronous
c. Polarsynchronous
d. Polysynchronized
e. None of the above

___ 13. How do microwave signals travel?

a. Around the earth several times before diminishing
b. With an arc of approximately 1°
c. Through the earth for around-the-world communications
d. All of the above
e. None of the above

___ 14. What does the horizontal axis of a spectrum analyzer represent?

a. Time
b. Voltage
c. Frequency
d. Power
e. Current

___ 15. Which are typical spectrum analyzer users?

a. FCC employees
b. Radio transmitter manufacturers
c. Radio service technicians
d. All of the above
e. None of the above

___ 16. What is the type of antenna called that is used by microwave receivers?

a. Parabolic reflector
b. Marconi
c. Flat
d. Polar reflector
e. None of the above

ANSWERS TO UNIT TEST

1.	e	(G3)	9.	b	(G4)
2.	c	(G3)	10.	a	(G4)
3.	d	(G3)	11.	d	(G4)
4.	a	(G3)	12.	b	(G3)
5.	ad	(G4)	13.	e	(G3)
6.	ab	(H5)	14.	c	(H5)
7.	b	(G4)	15.	d	(H5)
8.	b	(G4)	16.	a	(G3)

END

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Date Filmed

March 29, 1991